March 10, 1964 W. J. HELWIG ETAL 3,123,957

APPARATUS FOR PROCESSING A PLURALITY OF ARTICLES OR MATERIALS

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Fig. 1.

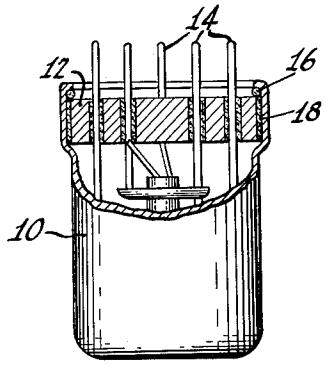


Fig. 3.

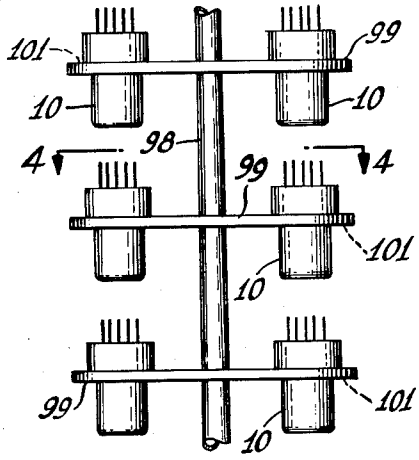
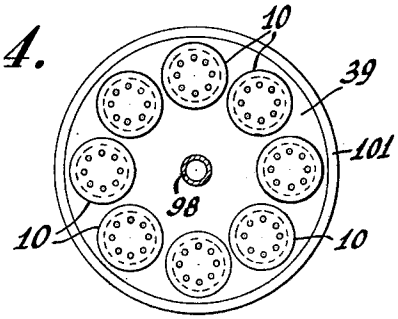


Fig. 4.



INVENTORS
WILLIAM J. HELWIG &
GEORGE M. ROSE, JR.
By William A. Zalesak
ATTORNEY

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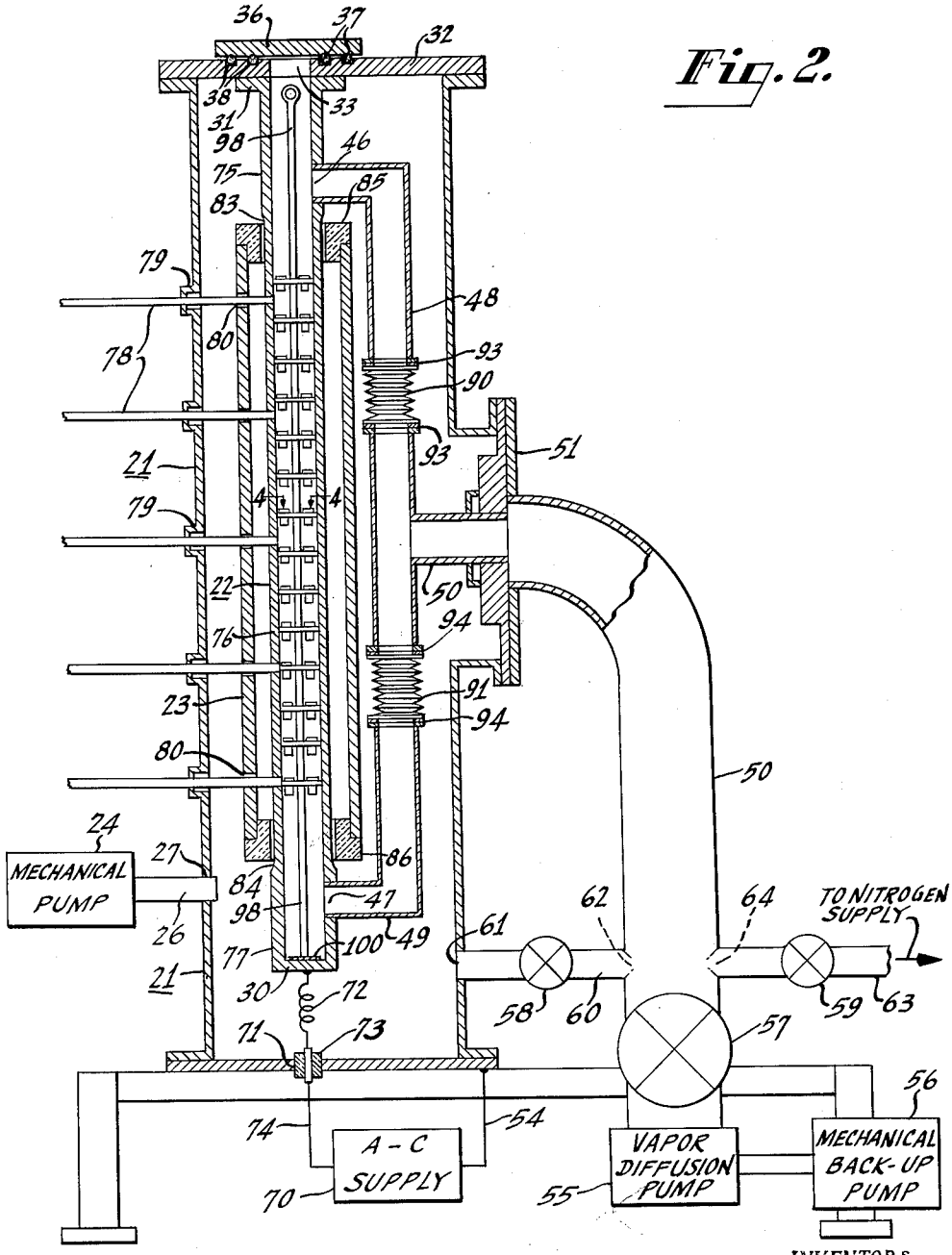
Filed March 22, 1960 2 Sheets-Sheet 2

Fig. 2.



INVENTORS
WILLIAM J. HELWIG &
GEORGE M. ROSE, JR.

BY William A. Zalesak
ATTORNEY

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APPARATUS FOR PROCESSING A PLURALITY OF ARTICLES OR MATERIALS

William J. Helwig, Kearny, and George M. Rose, Jr., Mountain Lakes, N.J., assignors to Radio Corporation of America, a corporation of Delaware

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This invention relates to apparatus for heat treating, evacuating and sealing evacuated articles, and particularly, with an improved means for batch heat treating, evacuating and sealing electron tubes.

While this invention will be described in connection with the processing of electron tubes, it is not so limited in its utility but has useful functions wherever vacuum and heat treating of articles is desirable.

One type of apparatus employed on a relatively large scale for processing electron tubes to provide an evacuated and sealed envelope is known as a sealex machine. This type of machine includes two turrets, on one of which a stem wafer is sealed to a bulb of an electron tube, and on the other of which the envelope formed by the stem and bulb is evacuated through an exhaust tubulation forming part of the envelope, and the tubulation then sealed off to completely and permanently seal the envelope.

However, certain other newly developed tube types having no exhaust tubulation in the envelopes thereof and requiring sealing of envelope parts after evacuation cannot be processed by conventional sealex machines.

For processing such other tube types and similar work pieces, use has been made of what is commonly known as a bell jar system. This system, which is a batch rather than a continuous process, includes a large demountable bell jar connected to a means of evacuation and containing some means of heating the work pieces therewithin. A disadvantage to the use of existing bell jar systems, however, is that they must be opened to the atmosphere each time the work pieces are loaded or unloaded. This exposes large surface areas of the evacuating system to the atmosphere on which gases may be occluded. Evolution of these gases from the surface areas during subsequent heat and vacuum treating of other batches of work pieces interferes with the efficient evacuation of the system and increases the time required to process each work piece batch. In addition, present means to heat the work pieces within the zone to be evacuated are relatively complicated and inefficient.

Accordingly, it is an object of this invention to provide an improved apparatus for batch processing devices to be heat treated, evacuated, and sealed off.

It is a further object of this invention to provide a convenient means for heating articles, such as electron tubes, in the process of evacuating and sealing them.

It is another object of this invention to minimize the amount of surface area of the evacuating apparatus exposed to the ambient atmosphere during loading and unloading of the evacuating means to reduce the amount of gas occluded in the evacuating apparatus.

A further object of this invention is to minimize the time required to heat treat, evacuate, seal and cool work pieces.

One embodiment of this invention comprises a structure including a hollow metal tubular evacuating chamber closed at one end and supported in and enclosed by a housing. The housing is hermetically tight and is never opened to the atmosphere, while the chamber, which is also hermetically tight, may be opened to the atmosphere for the loading and unloading of electron tube work pieces therein through a hermetically sealable door.

Communicating with the interiors of both the chamber and the housing are separate and independent evacuating

means. Also, valve means are provided for interconnecting the chamber and the housing, and for sealing the one from the other, whereby the evacuating means may be connected to evacuate the chamber and the housing simultaneously or separately.

To provide heating of the electron tube work pieces within the chamber, the wall of the chamber is made of electrically resistive material. Electrical connections are supplied to the ends of the chamber so that current may be passed through the chamber walls from end to end to heat the chamber and the electron tube work pieces therein.

In operation, the housing evacuating means is allowed to evacuate the housing to a relatively low gas pressure, and during loading and unloading of electron tube work pieces from the chamber the valve means between the chamber and housing is kept closed. After the closing and the sealing of the chamber from the atmosphere, the valve means between the housing and the chamber is opened to allow a rapid initial evacuation of the chamber into the housing. The housing pressure increases somewhat by this flow of gases, and the housing and the chamber are further evacuated by the housing evacuating means. Since the volume of the housing is significantly larger than that of the chamber, the housing gas pressure is increased only slightly and the subsequent time to evacuate it and the chamber to a low pressure is short.

After this period of mutual evacuation, the valve means between the chamber and housing is closed, and the tube evacuation means are then employed to further lower the gas pressure within the chamber.

Current is then passed through the chamber walls of high electrical resistivity and the heat produced thereby is applied by thermal radiation for heat processing the electron tube work pieces within the chamber.

In the processes to be more fully described below, the electron tube work pieces are heat and vacuum treated and then permanently sealed. At the conclusion of these processing steps, a gas is directed into the chamber to cause rapid cooling of it and its contents. The gas used for this purpose is a noncorrosive one that will not be occluded on the inside walls of the chamber. Also, when the chamber door is opened to the atmosphere, the presence of this noncorrosive gas will protect the chamber from an excessive inflow of corrosive atmosphere gases.

It will be noted that the heat supplied to heat the work pieces within the chamber is conserved due to the fact that the evacuated space between the housing and the chamber is an excellent heat insulator. Also, because of the low gas pressure surrounding the chamber, gas leakage into the chamber through its sealed joints is minimized. This allows for a rapid and efficient evacuation of the chamber to the very low gas pressure essential for the processing of the electron tube work pieces.

Further features and advantages of the invention will become apparent as the present description of an embodiment thereof proceeds.

In the drawing, to which reference is now made for a consideration of one embodiment of the invention, by way of example:

FIGURE 1 is an enlarged view in elevation, partly broken away, of envelope work pieces that may be processed by an apparatus according to the invention;

FIGURE 2 is a longitudinal section of an apparatus embodying the invention;

FIGURE 3 is an enlarged view of a portion of FIGURE 2 showing a work holder and workpieces; and

FIGURE 4 is a section taken along the line 4—4 of FIGURE 3.

Referring to FIGURE 1, the work pieces to be produced by the apparatus of this invention may comprise a metal bulb 10 made of steel, for example, and an electron

tube mount including a stem wafer 12, made of a ceramic, such as Forsterite, having lead wires 14 extending therethrough and supporting electrodes therein, as shown in FIGURE 1. A ring 16 of any well-known soldering material having a melting temperature of about 1000° C. is disposed adjacent to the periphery of the wafer 12, and the end of the bulb 10, which is closed by loosely positioning the wafer 12 thereon. The periphery of the wafer 12 may have a metallic coating 18 thereon, made of molybdenum, for example.

A processing of the described work pieces by apparatus, made according to the invention, involves degassing metal components of the electron tube by heating, activating a cathode, also by heating, and sealing the periphery of the wafer 12 to the inner wall of the bulb 10.

When the bulb 10 and the wafer 12 are in loosely assembled position shown in FIGURE 1, efficient communication between the space defined by the bulb and wafer and the exterior is provided, so that when the parts referred to are placed in an ambient or reduced gas pressure, the gas pressure within the envelope formed by the bulb and wafer is reduced correspondingly. Furthermore, in the position of the electron tubes as shown in FIGURES 1, 2 and 3, a heating of the solder ring 16 to its melting point temperature will cause the melted solder to flow downwardly between the periphery of the wafer 12 and the inner wall of the bulb 10, to provide a hermetic seal therebetween when the solder is cooled to hardness.

For accomplishing the foregoing heat treatment and vacuum processing of the electron tube work pieces described, an apparatus according to the invention is provided including a cylindrical tank 21 including an evacuable chamber 22 therein, which in turn is partially surrounded by a heat shield 23, as shown in FIGURE 2. In one embodiment, tank 21 is about four feet in length and has a diameter of one foot.

Except for means hereinafter described, tank 21 and chamber 22 are hermetically sealed from one another, and a flow of gases between the two is permitted only at certain specified times. Also, tank 21 is permanently sealed from atmospheric pressure. A mechanical pump 24, of any type well known in the art, communicates with tank 21 by means of a duct 26 and aperture 27 in the wall of the tank. In the embodiment shown, pump 24 has a capacity of 15 cu. feet per minute which is sufficient to maintain the gas pressure of the volume within the tank surrounding chamber 22 at a value of about 10×10^{-3} mm. of mercury.

Chamber 22 is closed at one end 30, and its other end terminates in a flange 31 which is rigidly attached as by welding to plate 32 closing the upper end thereof of tank 21. Plate 32 has a hole 33 in register with the end of chamber 22, and access may be obtained to the interior of the chamber 22 therethrough. A vacuum tight closure door must be provided for the chamber, which may be any of a variety of commercially available gate style vacuum valves such as Vacuum Research Company VG102T. As shown in FIGURE 2, however, the door in this embodiment comprises simply a circular plate 36 contacting deformable sealing members 37, such as commercially available O rings, which sit in annular grooves 38 in plate 32. As will be described, chamber 22 is evacuated and atmospheric pressure forcibly presses plate 36 against the sealing members 37 which are deformed to fill up and seal the region between them and plate 36. The connection between flange 31 and plate 32 is vacuum tight and removal of plate 36 does not open the interior of tank 21 to the atmosphere.

In this embodiment of the invention, the outer diameter of the chamber 22, for reasons hereinafter disclosed, may vary between 2⅛ to 2¼", while the inner diameter of the chamber is a constant 2". Also, the chamber is three feet long. Flange 31, fastened to plate 32, mentioned above, provides the sole support of the chamber, which extends otherwise freely into tank 21.

Communication to the interior of chamber 22 for the purpose of its evacuation is made through apertures 46 and 47 in the wall which open into ducts 48 and 49, respectively. Ducts 48 and 49, in turn, lead to duct 50, which passes through the side of tank 21, through a vacuum tight seal 51, to suitable pumps. As later described, the vacuum processing of the electron tube pieces takes place within chamber 22. It is thus desirable that this chamber be evacuated to a low pressure of around 2 to 4×10^{-6} mm. of mercury. To accomplish this, the above-mentioned pumps comprise a vapor diffusion pump 55 with a capacity, for example, of 1400 liters per second, backed up by a mechanical pump 56 with a capacity of, for example, 15 cubic feet per minute.

As shown in FIGURE 2, three valves 57, 58 and 59 are provided to control the flow of gases within the apparatus.

Valve 57 is provided to isolate and protect the sensitive vapor diffusion pump 55 from duct 50 during the times when chamber 22 and duct 50 are opened to atmospheric pressure.

Valve 58, along with tubulation 60 opening into tank 21 and duct 50 through vacuum sealed apertures 61 and 62, respectively, permits the flow of gases between chamber 22 and tank 21, as previously mentioned.

And finally, valve 59 permits the inflow of a noncorrosive gas such as nitrogen, into duct 50 and chamber 22 through tubulation 63. The tubulation 63 is connected to a source of nitrogen and opens into duct 50 through vacuum sealed aperture 64.

As mentioned, the electron tube work pieces are processed within chamber 22, and to provide heating thereof, chamber 22 may be made of any one of a number of materials well known in the trade such as an alloy known as Inconel, composed of iron, cobalt and nickel, and which has high hot strength, low thermal conductivity, and relatively high electrical resistivity. The passage of a current through the chamber walls thus results in a conversion of electrical energy to thermal energy, which is radiated to the work pieces. An electrical energy supply 70 is provided, which is connected by means of connecting wires 74 and 72 to the bottom end 30 of chamber 22 through a vacuum tight and insulating seal 71 in the end of tank 21. The complete electrical circuit comprises connecting wires 74 and 72, and the chamber 22, with the tank walls and wire 54 serving as the return path to the electrical supply. Ceramic insulator 73 is provided to electrically insulate connection 74 from the tank walls. The electrical connecting link 72 to chamber 22 within tank 21 is necessarily flexible so as not to interfere with the expansion of chamber 22 when it is heated.

To centralize the chamber heating, the wall thickness of the chamber is varied to control the amount of heating caused by the current flow. Thus, for about a length of six inches from flange 31, chamber portion 75 has walls with a thickness of about 125 thousandths of an inch, while for a length of about two feet, the wall thickness of the central portion 76 of the chamber is but 70 thousandths of an inch, with the remaining six inch portion 77 again having a wall thickness of 125 thousandths of an inch. The differences in ohmic resistance per unit length created by the different wall thicknesses are such that when the current passes through the chamber walls the central thin wall portion becomes very hot, while the end portions remain relatively cool.

To measure and control the heating of chamber 22 and the electron work pieces therewithin, thermocouples 78 are provided which extend through vacuum tight seals 79 in the side of tank 21, through holes 80 in shield 23, and which are fixed at different points along the chamber wall.

In operation, it has been observed that the temperature over the central portion of chamber 22 is quite uniform, and it has not been necessary, in this embodiment, to

provide means to equalize the temperatures of different portions of the heated section of the chamber.

From FIGURE 2, it is noted that the internal cross-section of chamber 22 remains constant while the external diameter of the chamber varies. Shoulders 83 and 84 are used to locate the ceramic insulation spacers 85 and 86, to which are fixed the heat shield 23. The ceramic spacers fit loosely around the chamber central portion to permit independent thermal expansion of the chamber and the shield, and also to prevent current flow through the shield. The shield is made of any shiny, highly reflective material, such as stainless steel, to reflect thermal radiated energy from the heated chamber portions back to the chamber.

Ducts 48 and 49 are rigidly connected to chamber 22, and to avoid interference with thermal expansion of the chamber, they are provided with bellows-like wall portions 90 and 91. These wall portions are made of a thin, convoluted material, such as stainless steel, and like bellows, are readily deformable to permit the axial length of ducts 48 and 49 to change along with the thermally induced changes in the chamber length. Small ceramic insulating disks 93 and 94 are used to fasten the wall portions 90 and 91 to the ducts 48 and 49. These disks are used to prevent current flow through and useless heating of the metallic ducts.

For properly locating the electron tube work pieces within the evacuation chamber 22, a charging rack, as shown in FIGURES 3 and 4, is provided which comprises a central support rod 98, to which are fixed a plurality of parallel and spaced disks 99. The disks have holes in them to receive electron tubes, as shown, and the entire charging rack with the loosely assembled electron tube work pieces therein, is inserted into the chamber 22 as in FIGURE 2. The lower end 100 of support rod 98 rests on the chamber closed end 30, and the disks are so positioned along the support rod to insure that the electron tubes are located within the thin walled portion of the chamber. The disks are about two inches in diameter, and engage the chamber walls to center the charging rack within the chamber. To prevent random current paths between the walls and portions of the charging rack, the edges 101 of the disks and the lower end 100 of support rod 98 are made of a ceramic insulating material. The remaining portions of the charging rack are preferrentially made of stainless steel, or other low thermal capacity material to facilitate rapid heating and cooling of the charging rack.

The detailed operation of this apparatus embodying the invention will now be described.

With all valves 57, 58 and 59 closed, tank 21 is preliminarily evacuated to a low gas pressure by pump 24. Pump 24 operates to evacuate tank 21 continuously, and in the processing of subsequent batches of electron tube work pieces, this preliminary tank exhaust step is unnecessary, as will be seen.

With plate 36 separated from the chamber opening, the charging rack, with a batch of loosely assembled electron tube work pieces therein, is inserted into chamber 22. Plate 36 is then located to close the chamber 22 and valve 58 between the tank 21 and duct 50 is opened to allow an initial evacuation of the chamber into the tank. The purpose of this initial evacuation is twofold: first, it provides rapid initial rough evacuation of the chamber; and, second, it serves to protect the sensitive vapor diffusion pump 55 from being overloaded by a charge of gases at atmospheric pressure. Valve 58 is left open and pump 24 is allowed to re-evacuate tank 21 along with chamber 22 and its associated ducts back to the original low pressure value of the tank.

Valve 58 is then closed and the valve 57 between duct 50 and pumps 55 and 56 is opened to allow these pumps to further lower the gas pressure in chamber 22 and the associated ducts.

It is noted that the efficiency and speed of the subsequent chamber evacuation is materially aided by the tube ambient low pressure established by evacuated tank 21. That is, the gas pressure differential between the interior of the evacuated chamber and most of its surroundings is maintained at a low value which minimizes gas leakage into the chamber.

When the evacuation of the chamber has produced a sufficiently low gas pressure, electrical current is passed through the walls of chamber 22, as previously described, and the electron tube work pieces therewithin are heated to a first series of predetermined temperatures. During this operation and the immediately following ones, pumps 55 and 56 continue to evacuate chamber 22.

These first temperatures reached by the electron tube work pieces are lower than the temperature necessary to melt the solder ring and to seal the tube, but are sufficient to drive off gases occluded on the electron tube parts and to properly activate the electron tube cathode. When these processes are completed, additional electrical currents are passed through the chamber walls to further raise the temperature of the electron tubes to the solder melting point. As described, the solder melts and flows downwardly through the joints between the wafer and the tube envelope.

The passage of electrical currents through the chamber walls is discontinued and the joints formed by the flow of solder are allowed to cool and harden. It is noted that since the evacuation of the chamber is maintained during the cooling and hardening of the soldered seals, no gas pressure differential is established between the interior of the sealed electron tubes and the evacuation chamber 22, and the soft cooling seal regions are subjected to no undue stresses.

Valve 57 is then closed, isolating pump 55 from the chamber, and valve 59 is opened to allow a flow of nitrogen into the chamber and around the sealed electron tubes. This inflow of nitrogen serves to hasten the cooling of the electron tubes and to shorten the processing cycle. The pressure within the chamber 22 is allowed to build up to slightly higher than that of atmospheric pressure, and plate 36 is then removed. The presence of the nitrogen gas within the chamber 22 protects it from an inflow of atmospheric gases which would tend to occlude onto the chamber and duct walls and make evacuation more difficult during processing of the next batch of work pieces.

The charging rack is removed, and a new batch is inserted into chamber 22 to repeat the cycle. The vacuum plate 36 is re-added, valve 59 is closed to stop the flow of nitrogen, and valve 58 may then be immediately opened. Tank 21, as described, is already at its low gas pressure, and time need not therefore be taken to re-evacuate it.

A further advantage to the low pressure region of tank 21 surrounding the heated chamber 22 is that it practically eliminates conductive and convective heat losses from most of the chamber surface.

Shield 23, in addition, reduces the heat loss due to thermal radiation; and in operation, the above two insulating means permit heating of chamber 22 well above red heat while the walls of tank 21 remain at a temperature below 100° C.

Holes 80 in shield 23 for the thermocouples 78 also serve to permit free flow of gases between the interior of the shield immediately surrounding chamber 22 and the remaining portions of tank 21 for efficient evacuation of the tank.

What is claimed is:

1. Apparatus for evacuating and sealing articles of manufacture having an envelope, said apparatus comprising an inner member providing a chamber for receiving articles of manufacture to be evacuated and sealed and means for heating said inner member, an outer housing member surrounding and enclosing said inner member and having a vacuum fit therewith, passage means for gas communication between said inner member and said outer

housing member, said passage means having a valve therein, evacuation means connected to said inner member, and evacuation means connected to said outer housing member, whereby said inner member and said outer housing member may be evacuated together when said valve is open, or both of said members may be evacuated separately when said valve is closed.

2. Apparatus for evacuating and sealing articles of manufacture having an envelope, said apparatus comprising an inner member providing a chamber for receiving articles of manufacture to be evacuated and sealed, an outer housing member substantially surrounding and enclosing said inner member and having a vacuum-tight fit therewith, said inner member being of a resistive material whereby said inner member may be heated by the passage of a current therethrough, first evacuating means communicating with said outer housing member, evacuating means communicating with said inner tubular member, and openable and closeable means for communicating gases between said inner member and said outer housing member.

3. Apparatus for evacuating and sealing articles of manufacture having an envelope, said apparatus comprising an inner member providing a chamber for receiving articles of manufacture to be evacuated and sealed, an outer housing member substantially surrounding and enclosing said inner member and having a vacuum-tight fit therewith, said inner member being of a resistive material whereby said inner member may be heated by the passage of a current therethrough, evacuating means communicating with the outer housing member, evacuating means communicating with said inner member and said outer housing member, said last evacuating means having means for closing communication with said outer housing member to provide communication with said inner member only and for providing communication between said inner member and said outer housing member.

4. Apparatus as in claim 3 wherein said inner member is supported at one end only whereby said inner member may expand and contract upon change of temperature therein.

5. Apparatus as in claim 4 and in addition thereof, a heat shield closely surrounding said inner member.

6. Apparatus for heating, evacuating and sealing articles of manufacture having an envelope and a closure member to be sealed to said envelope, said apparatus comprising an inner tubular member providing an elongated chamber for receiving said articles of manufacture, an outer tubular member substantially surrounding and enclosing said inner tubular member and having a vacuum-tight fit therewith, said inner tubular member being of a resistive material whereby said inner tubular member may be heated by the passage of a current therethrough, evacuating means communicating with said outer tubular member, evacuating means communicating with said inner tubular member and said outer tubular member, said last evacuating means having means for closing communicatation with said outer tubular member to provide communication with said inner tubular member only and for providing communication between said inner and said outer tubular members.

7. Apparatus for heating, evacuating and sealing articles of manufacture having an envelope and a closure member to be sealed to said envelope, said apparatus comprising an inner tubular member provided an elongated chamber for receiving said articles of manufacture, an outer tubular member substantially surrounding and enclosing said inner tubular member and having vacuum-tight fit therewtih, said inner tubular member being of a resistive material whereby said inner tubular member may be heated by the passage of a current therethrough, said inner tubular member being supported at one end only whereby said member may expand and contract upon change of temperature therein, evacuating means communicating with said outer tubular member, evacuating means communicating with said inner tubular member and said outer tubular member, said last evacuating means having means for closing communication with said outer tubular member to provide communication with said inner tubular member only and for providing communication between said inner and said outer tubular members.

8. Apparatus for heating, evacuating and sealing articles of manufacture having an envelope and a closure member to be sealed to said envelope, said apparatus comprising an inner tubular member providing an elongated chamber for receiving said articles of manufacture, an outer tubular member substantially surrounding and enclosing said inner tubular member and having a vacuum-tight fit therewith, said inner tubular member being of a resistive material whereby said inner tubular member may be heated by the passage of a current therethrough, and means for supporting said inner tubular member whereby said member may expand and contract upon change of temperature therein, a heat shield closely surrounding and insulatingly supported on said inner tubular member, evacuating means communicating with said outer tubular member, evacuating means communicating with said inner tubular member and said outer tubular member, said last evacuating means having means for closing communication with said outer tubular member to provide communication with said inner tubular member only and for providing communication between said inner and said outer tubular members.

9. Apparatus for heating, evacuating and sealing articles of manufacture having an envelope and a closure member to be sealed to said envelope, said apparatus comprising an inner tubular member providing an elongated chamber for receiving said articles of manufacture, an outer tubular member substantially surrounding and enclosing said inner tubular member and having a vacuum-tight fit therewith, said inner tubular member being of a resistive material whereby said inner tubular member may be heated by the passage of a current therethrough, said inner tubular member being supported at one end only whereby said member may expand and contract upon change of temperature therein, a heat shield closely surrounding and insulatingly supported on said inner tubular member, evacuating means communicating with said outer tubular member, evacuating means communicating with said inner tubular member and said outer tubular member, said last evacuating means having means for closing communication with said outer tubular member to provide communication with said inner tubular member only and for providing communication between said inner and said outer tubular members.

10. The apparatus as described in claim 9, wherein the walls of said inner tubular member have greater electrical resistivity along one portion than along another portion thereof.

11. The apparatus as described in claim 10, wherein said one portion is thinner than said other portion.

12. Apparatus for evacuating and sealing articles of manufacture having an envelope and a header to be sealed thereto, said apparatus comprising an inner tubular member providing an elongated chamber for receiving articles of manufacture to be evacuated and sealed, an outer tubular member substantially surrounding and enclosing said inner tubular member and having a vacuum-tight fit therewith, said inner tubular member being of a resistive material whereby said inner tubular member may be heated by the passage of current therethrough, and means for supporting said inner tubular member whereby said inner tubular member may expand and contract upon change of temperature therein, a heat shield closely surrounding and insulatingly supported on said inner tubular member, evacuating means communicating with said outer tubular member, evacuating means communicating with said inner tubular mem-

ber and said outer tubular member, said last evacuating means having means for closing communication with said outer tubular member to provide communication with said inner tubular member only and for providing communication between said inner tubular member and said outer tubular member, the evacuating means communicating with said inner and outer tubular members including a tubular means connected between the ends of said inner tubular member and provided with flexible coupling elements to permit expansion and contraction of said inner tubular member, said last evacuating means being provided with a conduit connecting said outer tubular member and said evacuating means and provided with cutoff means.

13. Apparatus for evacuating and sealing articles of manufacture having an envelope and a header to be sealed thereto, said apparatus comprising an inner tubular member providing an elongated chamber for receiving articles of manufacture to be evacuated and sealed, an outer tubular member surrounding and enclosing said inner tubular member and having a vacuum-tight fit therewith, the walls of said inner tubular member having portions thereof of different thicknesses of a resistive material whereby said wall portions may be preferentially heated, said inner tubular member being supported at one end only whereby said member may expand and contract upon change of temperature therein, a shiny, reflective heat shield closely surrounding and insulatingly supported on said inner tubular member, evacuating means communicating with said outer tubular member, evacuating means communicating with said inner tubular member and said outer tubular member, said last evacuating means hving means for closing communication with said outer tubular member to provide communication with said inner tubular member only and for providing communication between said inner tubular member and said outer tubular member, the evacuating means communicating with said inner and outer tubular members including a duct means connected between the ends of said inner tubular member and having at least one wall portion therein comprising a bellows, said bellows composed of convoluted, easily deformable thin material for permitting expansion and contraction of said inner tubular member, said duct means being provided with a conduit connecting said outer tubular member and said evacuating means and provided with cutoff means.

14. Apparatus for evacuating and sealing articles of manufacture having an envelope and a header to be sealed thereto, said apparatus comprising an inner tubular member providing an elongated chamber for receiving articles of manufacture to be evacuated and sealed, an outer tubular member surrounding and enclosing said inner tubular member and having a vacuum-tight fit therewith, said inner tubular member being of a resistive material whereby said inner tubular member may be heated by the passage of current therethrough, said inner tubular member being supported at one end only whereby said member may expand and contract upon change of temperature therein, a heat shield closely surrounding and insulatingly supported on said inner tubular member, evacuating means communicating with said outer tubular member, evacuating means communicating with said inner tubular member and said outer tubular member, said last-evacuating means having means for closing communication with said outer tubular member to provide communication with said inner tubular member only and for providing communication between said inner tubular member and said outer tubular member, and means for providing communication between said inner tubular member and a source of flushing gas, and said inner tubular member being provided at the supported end thereof with a removable vacuum-closure member to permit access to the interior of said inner tubular member.

15. Apparatus for evacuating and sealing articles of manufacture, said apparatus comprising an inner member providing a chamber for receiving articles of manufacture to be evacuated and sealed, an outer housing member substantially surrounding and enclosing said inner member, means for providing hermetic sealing of said members from one another, means adapted for receiving power from a source for heating said inner member, and passageways communicating with each of said outer housing member and said inner member allowing evacuation of said members.

16. Apparatus for evacuating and sealing articles of manufacture comprising an inner member providing a chamber for receiving articles of manufacture to be evacuated and sealed, an outer housing member substantially surrounding and enclosing said inner member, means adapted for receiving power from a source for heating said inner member, and means for evacuating said inner and outer members together and for evacuating said inner and outer members separately, said last-named means including means for hermetically sealing said inner and outer members from one another.

17. Apparatus for evacuating and sealing articles of manufacture comprising an inner member providing a chamber for receiving articles of manufacture to be evacuated and sealed, an outer housing member substantially surrounding and enclosing said inner member and having a vacuum-tight fit therewith, means adapted for heating said inner member, passageways communicating with said outer housing member and passageways communicating with the inner member allowing evacuation of said housing member and said inner member, and means for providing and closing off communication between said inner member and said outer housing member.

18. Apparatus for evacuating and sealing articles of manufacture, said apparatus comprising an inner member providing a chamber for receiving articles of manufacture to be evacuated and sealed, an outer housing member substantially surrounding and enclosing said inner member, means for providing hermetic sealing of said members from one another, the wall of said inner member being of electrically resistive material to permit heating thereof, and passageways communicating with each of said outer housing member and with said inner member allowing evacuation of said members.

19. Apparatus as in claim 18 wherein the wall of said inner member has greater electrical resistivity along one portion than along another portion thereof.

20. Apparatus for evacuating and sealing articles of manufacture comprising an inner member providing a chamber for receiving articles of manufacture to be evacuated and sealed, an outer housing member substantially surrounding and enclosing said inner member, the wall of said inner member being of electrically resistive material permitting heating thereof, and means for evacuating said inner and outer members together and for evacuating said inner and outer members separately, said last-named means including means for hermetically sealing said inner and outer members from one another.

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